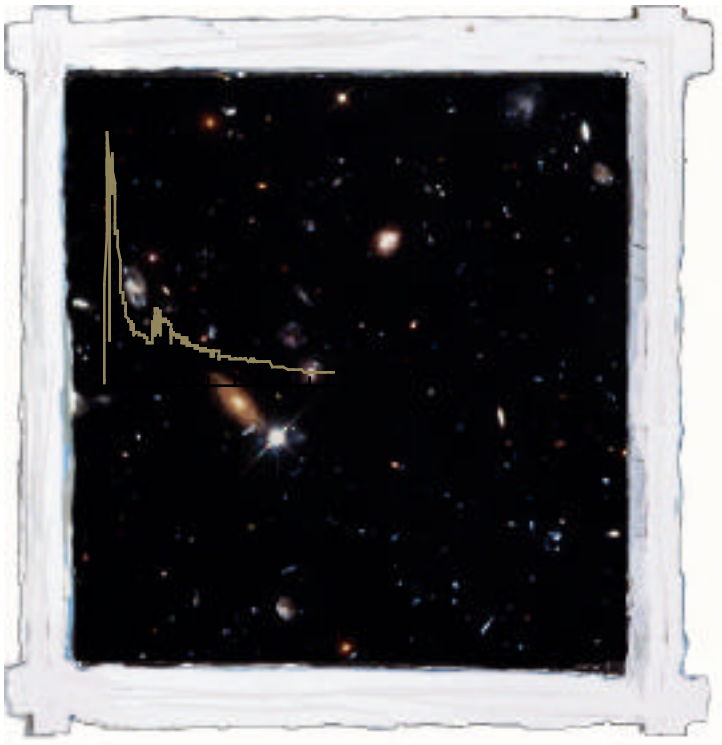
ORIGINS / NGST



THE NEXT GENERATION SPACE TELESCOPE

"Visiting a Time When Galaxies Were Young"
-from HST and Beyond, AURA

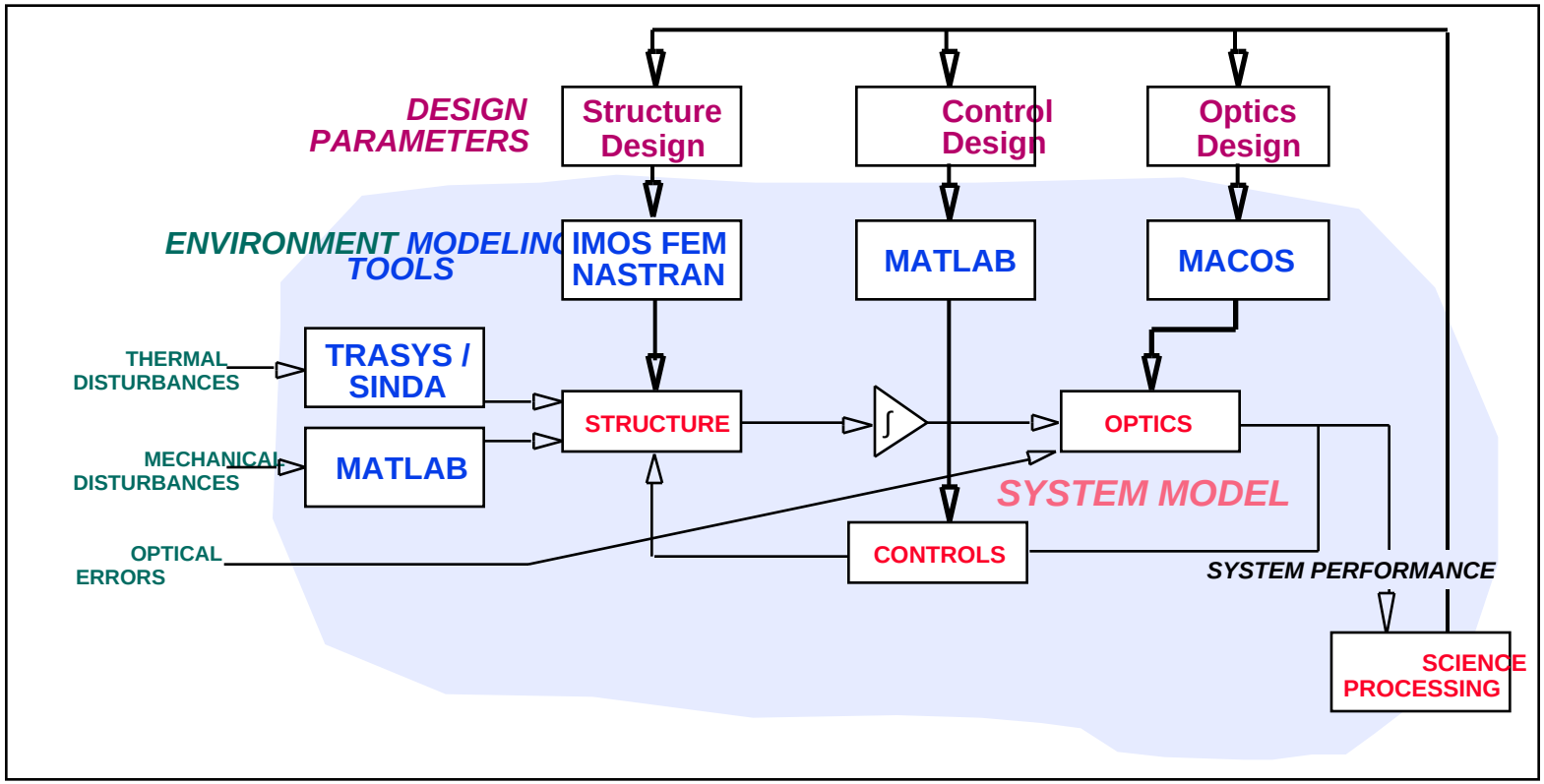
Integrated Modeling and Simulation Status

Gary Mosier
Goddard Space Flight Center

October 9, 1997

Integrated Modeling S/W Environment

NGST



- Integrated performance models quantify thermal, structural, control, optics, detector and system issues in terms of science impact
  - *Time-domain simulation, frequency-domain analysis, statistical analysis modes*
  - *Software testbed for attitude control and optical control/alignment algorithms*
- Model and tool validation via experiments on testbeds, other instruments

Modeling Highlights - S/W Environment

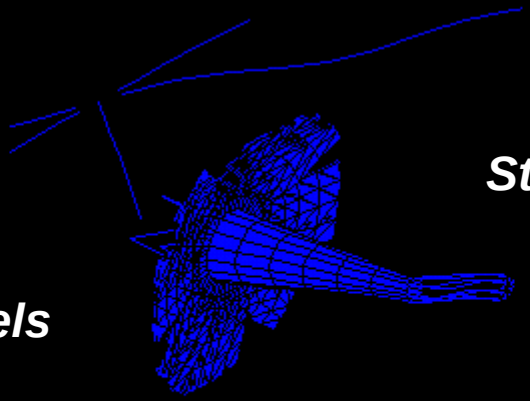
NGST

- DCATT WFS/WFC models delivered to GSFC
- Added “Mode Movie” capability -- Matlab animations that show qualitative opto-mechanical interactions
- Upgraded simulation to Matlab 5.x/Simulink 2.x (object-oriented, many useful new features)
- Optimized versions of IMOS functions now in place (~20x run-time improvement)
- NGST Integrated Modeling Environment was presented at the annual Matlab Conference, this week in San Jose
- Demos of our modeling environment and capabilities were rehearsed, and rehearsed, and rehearsed… but Wes Huntress never showed!!!

OptoMechanical Design Analysis

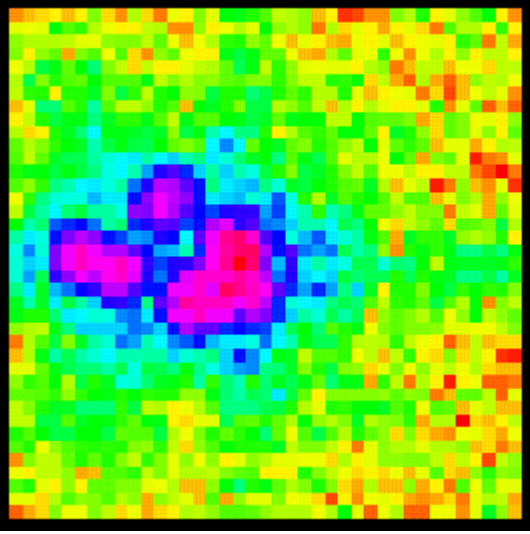
NGST

The NGST modeling tools integrate structural finite element models with optical models

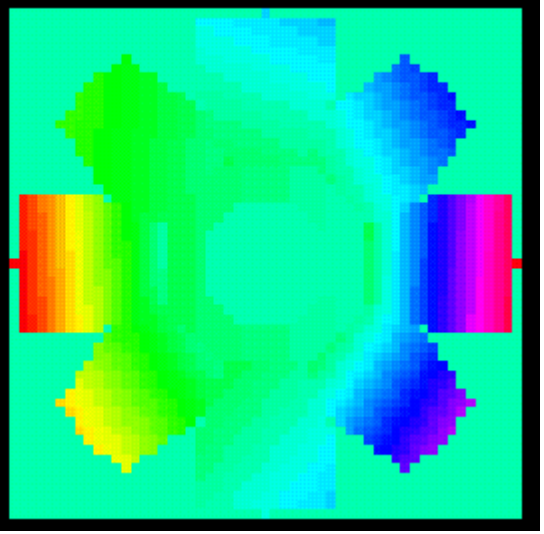


Structural FEM

Pixillated Image

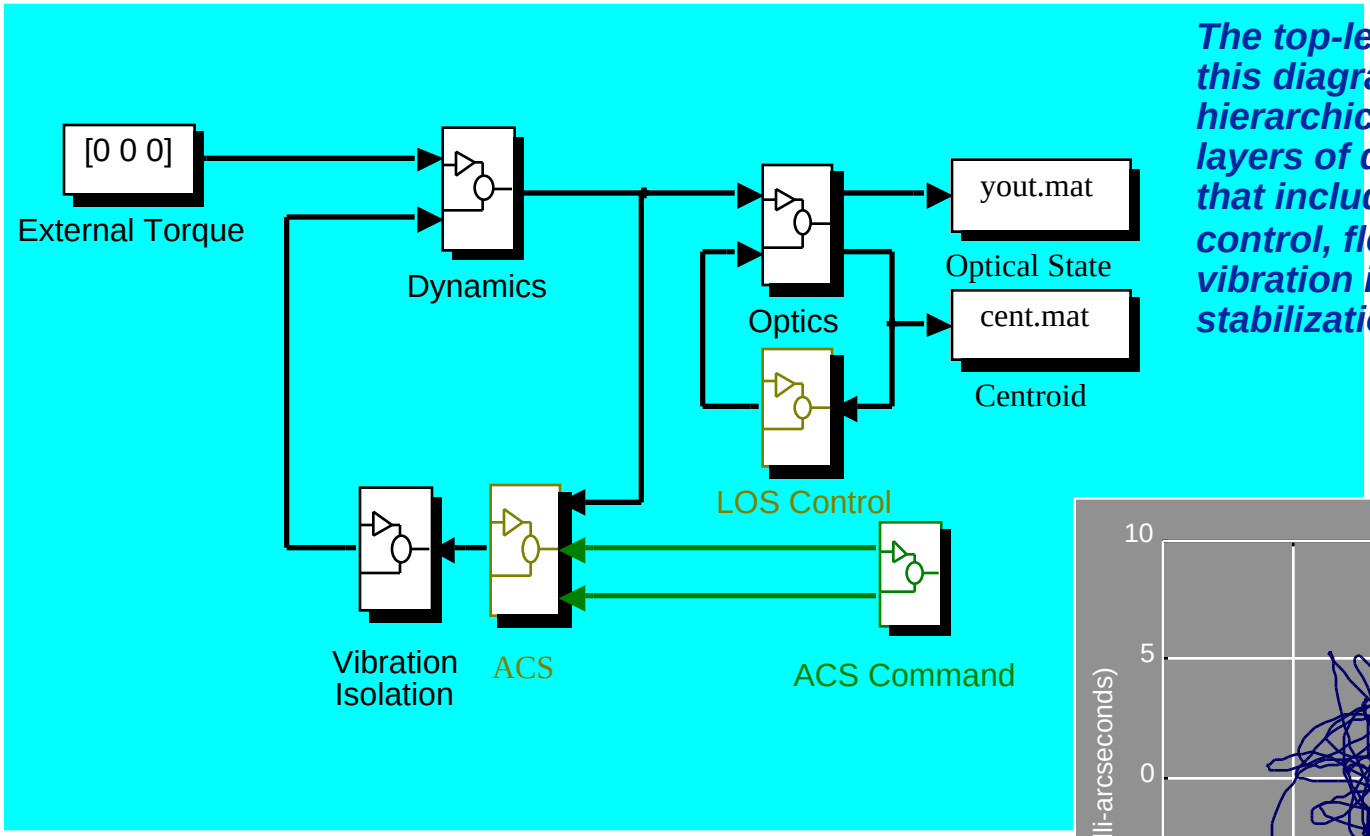


Wavefront Error

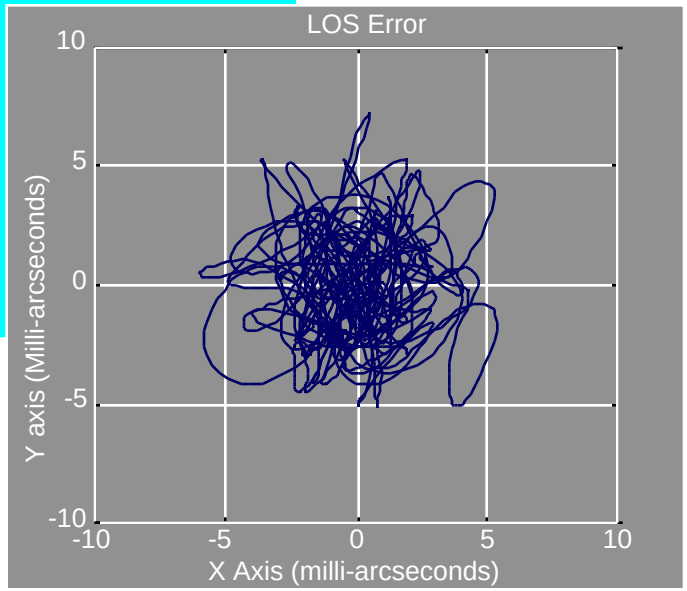


Rapid Prototyping via Simulation

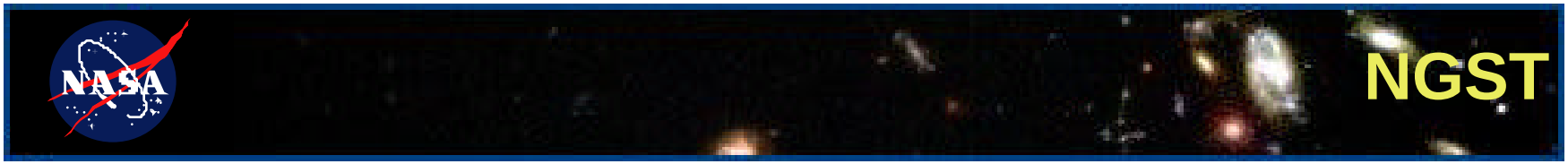
NGST



The top-level blocks shown in this diagram mask a complex hierarchical model with many layers of depth in a simulation that includes vehicle attitude control, flexible body dynamics, vibration isolation and image stabilization control, and optics



Modern, object-oriented, graphical programming environment enables rapid prototyping of high-fidelity simulations that can answer "what-if" questions and quickly cover vast parametric trade spaces


NGST

OTA Design Trade Study, Part I

NGST

- A point-design trade study is being conducted to assess several different OTA designs
  - Be on GrEp PM segments (ngst522)
  - Be on Be PM segments (ngst603)
  - Be on Be PM segments w/ beefed-up SM truss (ngst925)
  - Be on GrEp PM segments w/ hexapod SM truss (not delivered)
- Primary metrics are LOS and RMS WFE
- Disturbance source is reaction wheels, using HST model scaled to NGST size requirements

FEM Mass Properties

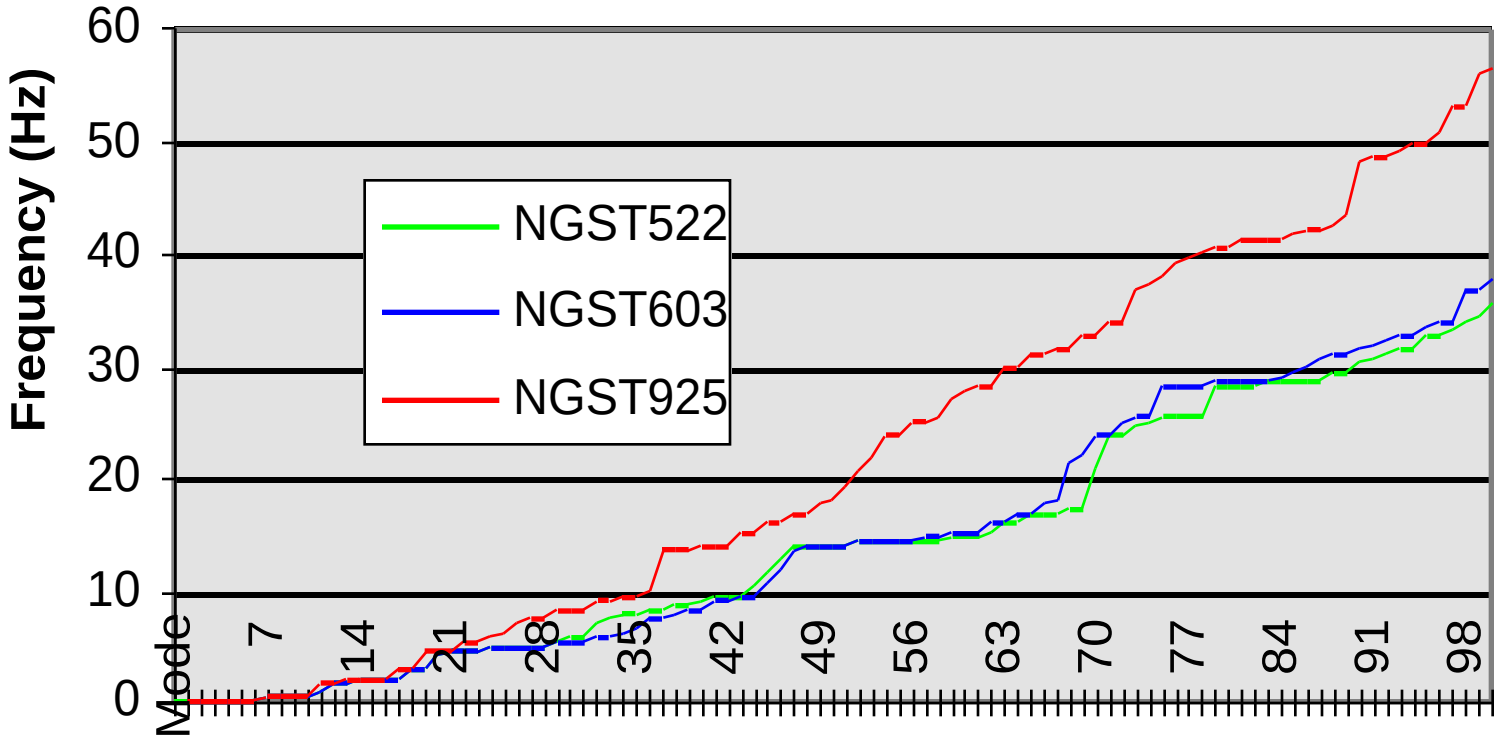
NGST

Model		Mass (kg)		Inertia @ c.m. (kg-m^2)		
ngst522		2218.60		12249.00	-136.10	6858.80
				-136.10	25084.00	114.13
				6858.80	114.13	17847.00
ngst603		2166.70		11641.00	-133.57	6722.80
				-133.57	24559.00	112.08
				6722.80	112.08	17435.00
ngst925		2205.20		11730.00	-142.47	7206.20
				-142.47	27476.00	113.63
				7206.20	113.63	20268.00

… very little difference between the designs in this respect

Eigenvalue Analysis

NGST



… the 9/25 model is much stiffer, as a system

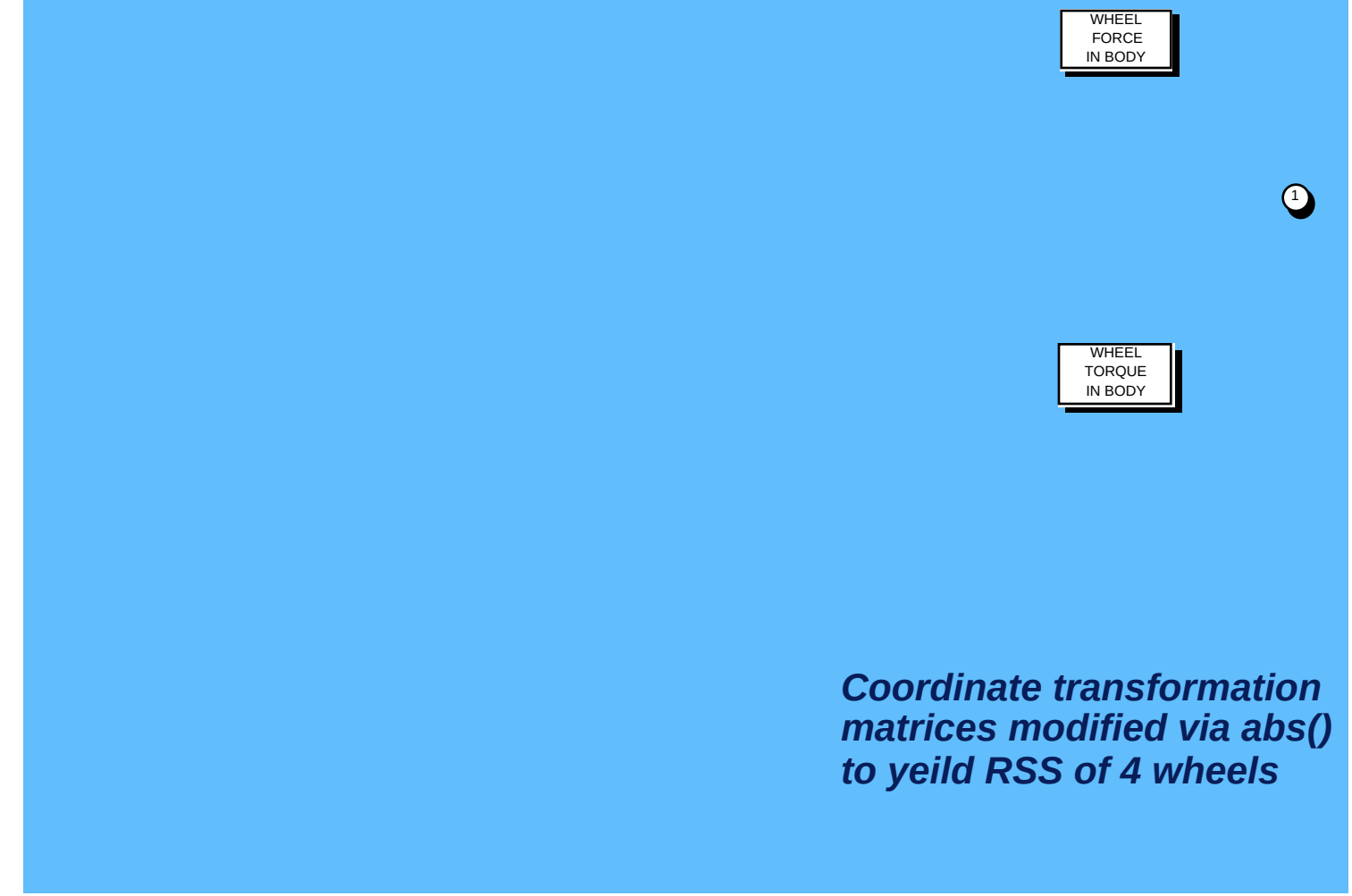
Wheel-toCentroid Linear Model

NGST

- *Linear Model used to generate LOS as a function of frequency*
- *ACS not included given its limited bandwidth*
- *Wheel disturbance is assumed to be a single white noise source*
- *Noise is scaled to yield the equivalent of 4 wheels phased to absolute worst case*
- *X and Y centroids RSS'ed to get LOS*

Wheel Force/Torque Model

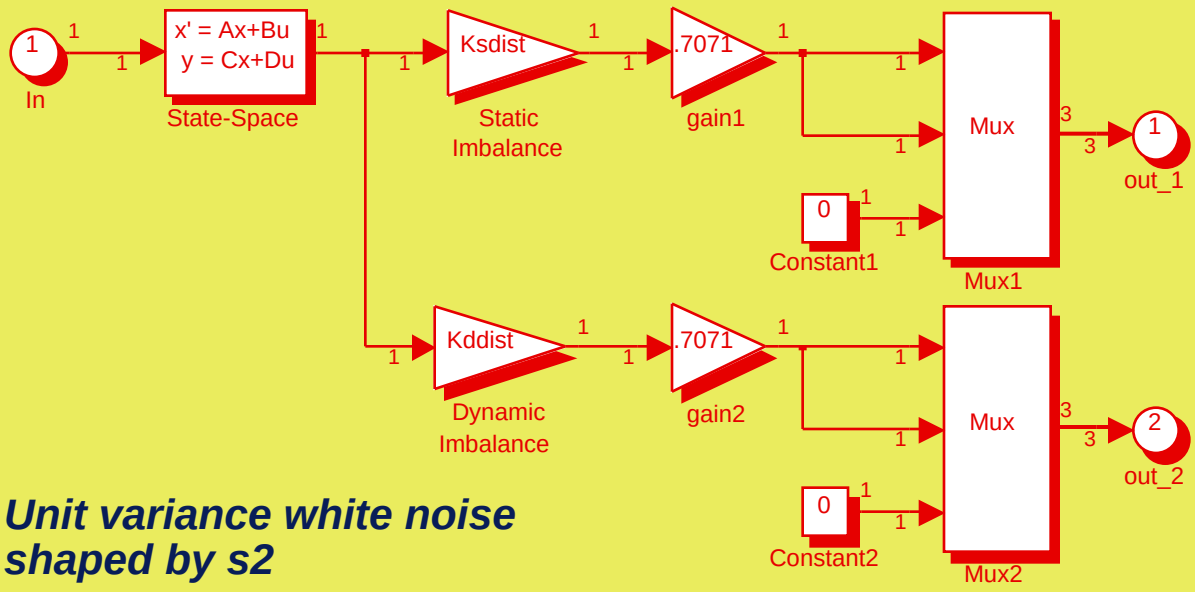
NGST



Coordinate transformation matrices modified via abs() to yeild RSS of 4 wheels

Wheel Noise Source

NGST

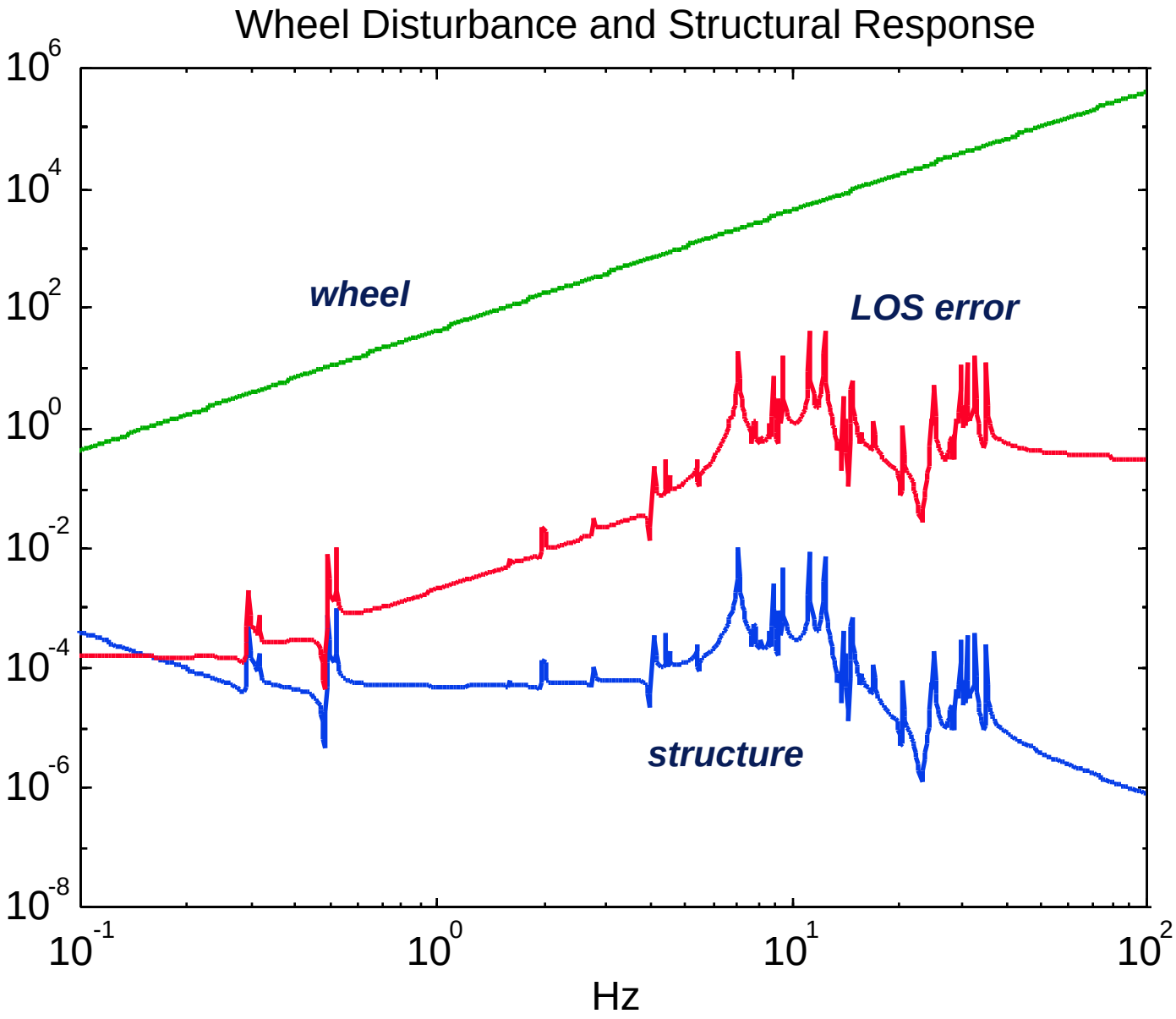


Unit variance white noise shaped by s2

Forces/Torques in wheel frame scaled by static/dynamic imbalance

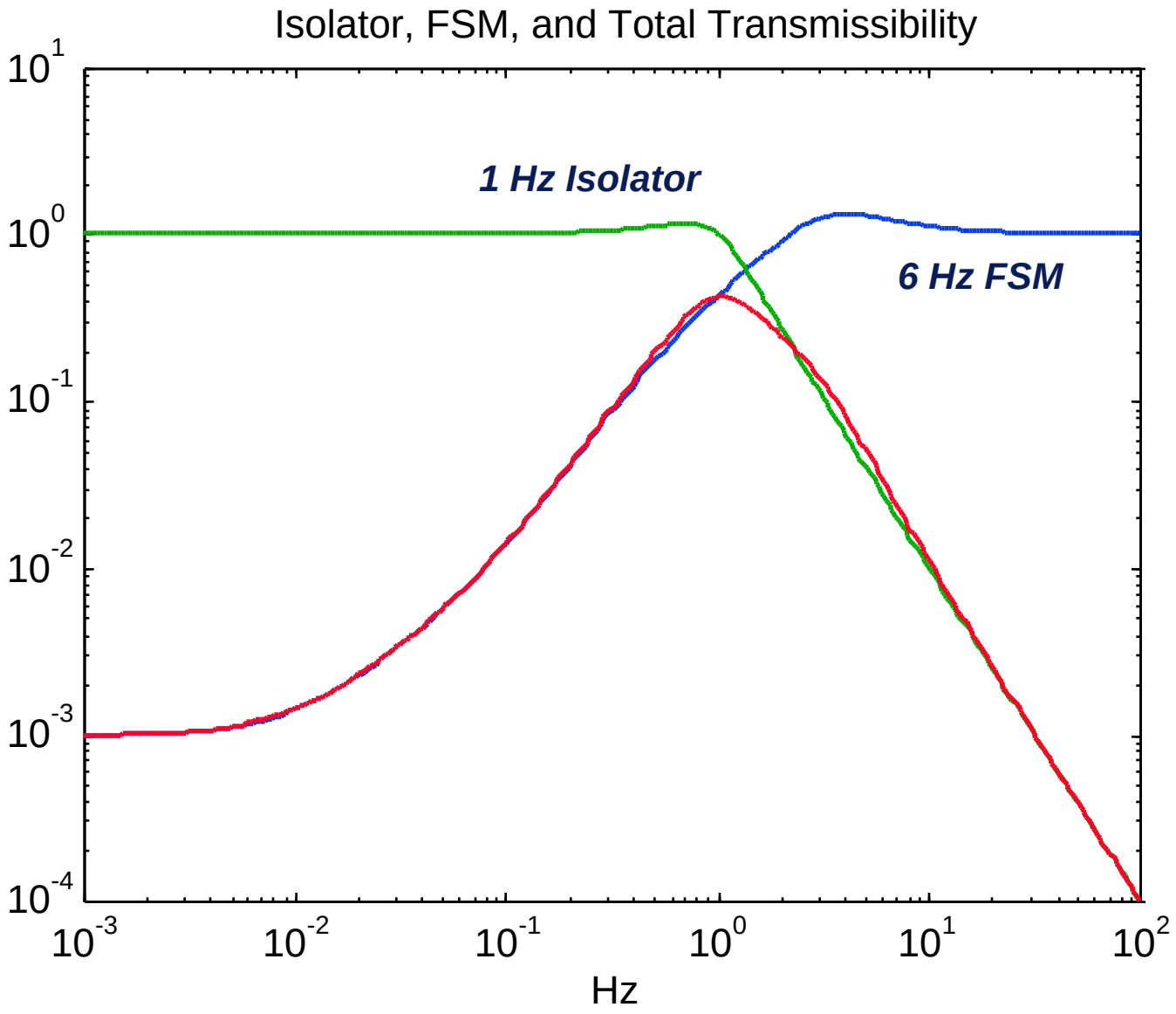
Effect of Wheels and FEM on LOS

NGST



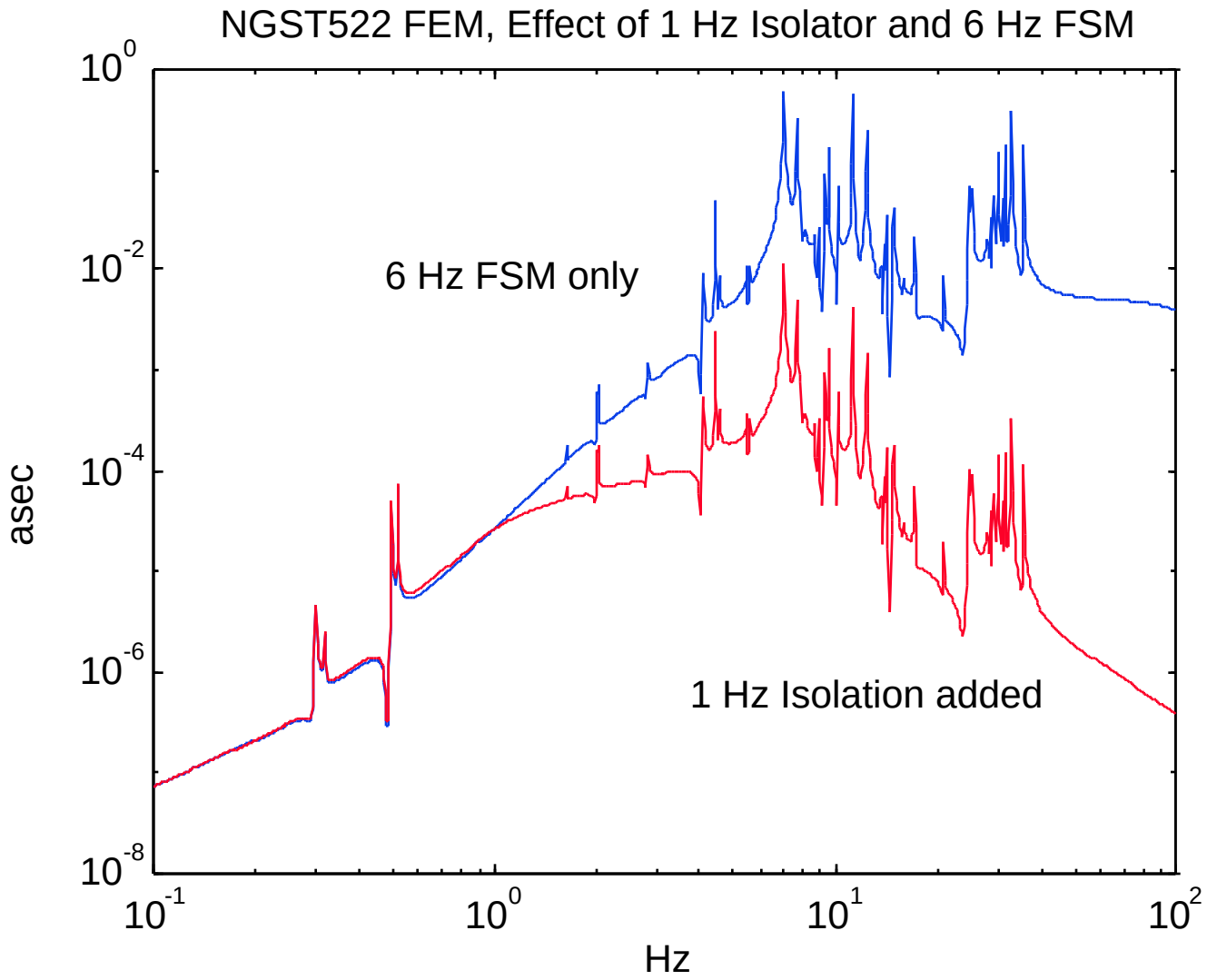
Effect of Isolation and FSM

NGST



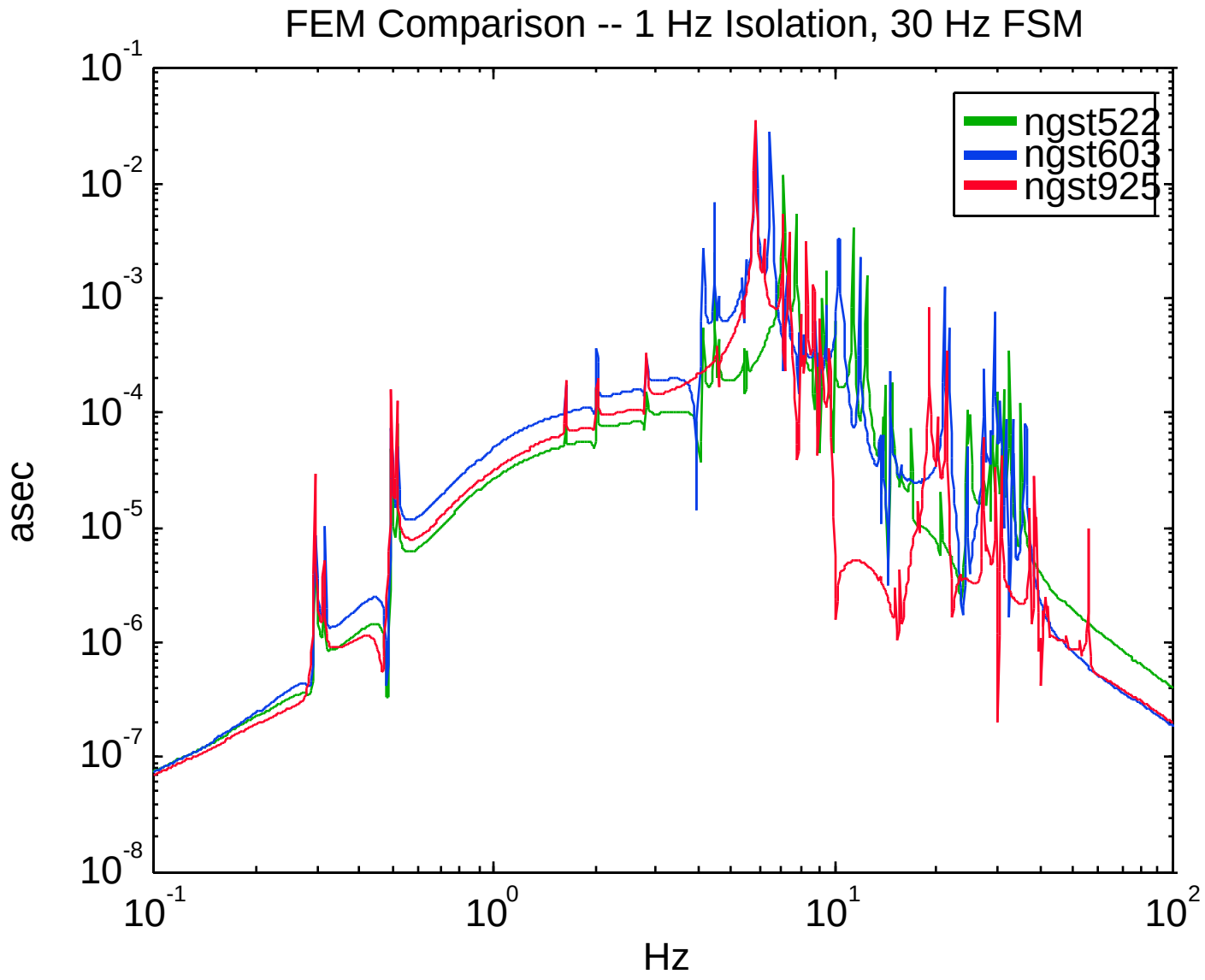
Net LOS Frequency Response

NGST



Comparison of the 3 FEMs

NGST



OTA Trade Summary

NGST

- Methodology needs refinement and additions
  - linear model too conservative by factor of at least 5, due to worst-case assumptions about wheel phasing
  - doesn't consider RMS WFE in the mode selection process
- Complete systems-level trade needs to include thermal analysis, diffraction analysis, etc.
- Preliminary results based on LOS, WFE, and mass properties leave little from which to choose

	LOS (SR)	LOS (SA)	LOS (LMA)	WFE (SR)	WFE (SA)
ngst522	8.5	2.7	11.7	0.123	0.023
ngst603	11.7	2.7	32.9	0.139	0.023
ngst925	9.8	2.7	35.5	0.118	0.023
LOS in milli-arcseconds			SR - simulation, raw		
WFE in microns			SA - simulation, attenuated		
simulations were 20 seconds			LMA - linear model, attenuated		

Near-term/Long-term Modeling Goals

NGST

- Continue OTA design trades and other parametric studies
- Add hooks for variable modal damping; study damping issue
- Design a “real” vibration isolation subsystem , incorporate into models and simulation
- Refine and enhance ACS design and models (slew and acquisition modes, thruster models, fuel slosh model, magnetic bearing wheel model, etc.)
- Develop models for PM actuators to support NGST and DCATT analysis; enhance fidelity of WFS/WFC models accordingly
- Coordinate thermal modeling software environments
- Integrate multi-body dynamics code (DADS) with simulation (Simulink) for deployment analysis
- Attend IMOS workshop at JPL in January
- Continue to support LaRC NextGrade development efforts

A Vision For Future Capabilities

NGST